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ABSTRACT

The desire to provide high quality instruction to an increasing number of students while maintaining or reducing costs has led to the development of mediated instructional modules. A model is described, which is used to predict the costs of using various alternative media to achieve the same instructional objectives for the same student population in order to determine the least cost method of instruction. The model, designed primarily for higher education, is based on the assumption of equal effectiveness for each alternative and focuses on the developmental, operational, and revisional costs of the instructional modules. (Author)

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Cost Effectiveness Analysis in the Development of Mediated Instructional Modules*

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PREFACE

The use of cost effectiveness analysis has once again become a topic of conversation for educational decision-makers. Yet, these conversations, when they occur, often result in a high degree of frustration and confusion simply because the participants are attaching different meanings to the same terms. Accountants, economists, and educational administrators legitimately approach the topic from varying perspectives. Therefore, it seems somewhat reasonable for any paper on cost effectiveness for general distribution to be prefaced with an indication of the author's perspective and the general area of focus.

The purpose of a cost effectiveness analysis is to predict the relationship between the amount of resources expressed in dollars required to engage in an activity (cost) and the amount of benefits which will be achieved by engaging in the activity (effectiveness). In order to perform such an analysis, both must be predicted. Typically, the relationship is predicted for several alternate activities and is then used as a basis for comparing them.

Two problems arise in the use of cost effectiveness analysis. First, the information necessary to make an intelligent prediction must be obtained. Second, the information must be analyzed in order to formulate the necessary predictions. One of two approaches is normally used to solve these problems. Assume the problem is to predict the cost effectiveness of three alternatives. One approach would be to actually produce and implement each alternative on a small scale. The costs would be

recorded and the effectiveness measured. This information would then be used to predict future costs and future effectiveness. This tactic seems most feasible when implementation of the alternative to be selected will require a great amount of resources and the potential savings will exceed the cost of performing the analysis.

The second approach consists of analyzing each alternative and making predictions based on the cost and effectiveness of similar alternatives which have been previously implemented. This procedure is somewhat similar to a contractor predicting the cost of constructing a home from his knowledge of the costs of building similar homes. This tactic seems most feasible for small scale projects.

This paper focuses on methods of analyzing the cost of previously implemented alternatives in order to predict the cost of an alternative which is being considered for possible implementation. While this type of an analysis requires knowledge of the costs previously incurred, this paper will not focus on the procedures used to collect, process, and record cost information. However, parts of a costing system developed by the author will be described when necessary to clarify the discussion. The reader who is interested in costing systems should refer to Appendix D for a list of individuals who are in various stages in the development and utilization of costing systems.

This paper focuses on the use of cost effectiveness analysis as a basis for comparing the use of various alternate media to achieve the same instructional objectives for the same student population. Because of a large body of research (discussed in Section II) which indicates that most mediums are equally effective, the problem of predicting effectiveness is

solved by assuming equal effectiveness for all alternatives. Many readers may find this solution and assumption untenable because of the current theory which postulates differential effectiveness of media. While this theory provides a valuable perspective for educational research, it provides little information to the decision-maker forced to select the instructional alternative to be implemented. If and when reliable procedures are established for determining a medium's instructional effectiveness in a specific environment, they may be easily incorporated into the model presented in this paper. However, the assumption of no difference in effectiveness is currently a logical interpretation of existing information and provides a more substantial basis for decision-making than popular but unsubstantiated theory.

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I. Introduction

Finance has overtaken discipline as the major problem of our public schools, according to the Third Annual Survey of the Public Schools, an opinion poll conducted by Gallup International. Although financing school operations was listed as the most important problem, fifty-two percent of the voters questioned were opposed to raising taxes. On the other hand, they were largely opposed to cutting services already offered by schools. Approximately half the public favors performance contracts and the use of management experts to assure that they get their money's worth from school operations. At all levels of education, from preschool through institutions of higher learning, diminishing resources and increasing demands for services are prompting the introduction of more effective management procedures. Techniques and methods which have proved successful in industry are increasingly being employed by educational decision makers to direct school expenditures into the most effective and economical channels.

Cost effectiveness analysis is one of these techniques which promises to be a powerful method for determining the optimal allocation of educational resources. While cost effectiveness is often discussed, it is not utilized by educational decision makers. This stems from both a lack of understanding of the technique and a lack of an adequate model for applying the technique to an instructional system. As Levin (1972) accurately points out

> Most of the people who claim they are doing work in cost effectiveness or cost benefit analysis have absolutely no understanding of the topic, or no training in the area. The result is that they use

very powerful words of analysis, while the studies supporting the rhetoric are either non-existant or are scandalously poor.

II. Review of Related Research

The results of the Gallup Poll cited earlier make it quite clear that the American public desires an increase in educational productivity. The public expects the education industry to provide the same services currently offered with the same number of dollars currently provided even though the purchasing power of these dollars is diminishing at an annual rate of approximately five percent ("Wages and Prices," 1971). Although it is not uncommon for corporate managers to demand an annual increase in productivity, it is rather unusual for educational administrators to make these same demands (Bowen, 1969). This, however, must change if the public is to be satisfied.

This demand for increased educational productivity is not only reflected in public opinion but is also manifested in several recent educational developments. Performance contracting schemes in which a school subcontracts with a private firm for those services which the school finds most difficult and most costly are examples of attempts to increase productivity (Bruno, 1972). The voucher plans which allow students to purchase education from competing schools is another attempt to force schools to increase their productivity (Boulding, 1972). These voucher plans place students in the role of education consumers who will hopefully try to buy the most education at the lowest price. The schools, on the other hand, are education producers who must manufacture a competitive product at a price the market will bear. Under the voucher plans, the

schools are forced to assume the same role as the private firms under performance contracting schemes.

While the demand for increased educational productivity is clear, the methods for achieving increased productivity are largely undetermined. While cost studies in education date from the scientific management movement of the early 1900's (Cooke, 1910) to the school finance equalization studies of the 1970's (Hickrod, et. al., 1972), these studies have been primarily concerned with the determination of the cost of education, the relationships between cost and quality, and methods for determining equal distribution of the educational dollar. Consequently, excellent procedures are available for determining the amount a given institution spent to produce a given number of graduates (Read, 1964; Evans and Hicks, 1962). Truly elegant models are available for the distribution of educational dollars throughout a state or school district (See Hickrod, 1971). These studies, however, were not designed to discover methods which allow schools to produce the same amount of services while reducing costs.

Commercial organizations faced with the problem of increasing productivity while maintaining or reducing costs utilize cost effectiveness or cost simulation techniques to evaluate alternative methods of production and to select the most appropriate method of production for their organization under a given set of market constraints. Basically these models compare various alternate methods of producing the same product. Comparisons are made on the number of units which can be produced in a given period; the resources required to produce each unit; the availability of the required resources; the cost of each unit; the predicted number of unit sales at various price levels; and the loss incurred by not using the available

resources in another manner. The value for each of these factors for each method of production is generally specified by a cost accountant. Since the accountant is dealing with proposed rather than operating production systems, he must estimate or predict costs. Naturally, the validity of the comparisons are directly related to the accuracy of the predictions. Once the costs have been specified, the various production methods are compared and analysed. The results of the comparisons are then used by management as the basis of selecting the most appropriate production technique. (For a more complete discussion see Carsberg, 1969.)

While cost effectiveness or cost simulation techniques have proven to be very valuable tools for commercial organizations, their relevance to educational problems is not clear. In theory, the concept of simulation seems quite applicable.

> An educator may ask whether expensive teaching devices will be worth their cost to his students. The final answer to any such questions must be found by experimentation done in the classroom under classroom conditions. However, the classroom is an expensive, inconvenient, and inflexible laboratory. The one final way to decide whether a bridge will stand is to build the bridge and see; but it is not sensible to build twenty bridges of various weights and types of construction to see which ones stand. Instead, laboratory studies and theoretical analyses are used to calculate what constitutes the best bridge. . . Combined with suitable mathematical theory, laboratory data can be used to answer questions about educational practice and to plan reasonable educational programs.
>
> (Restle, 1964, p. III)

Nevertheless, Hopkins (1972), after reviewing the literature on the use of large scale simulation models for university planning, concluded that the cost required to implement the model exceeded the savings achieved through the use of the model. Hopkins' argument is based primarily on the huge cost of assembling and processing the data the model requires. However,

Hopkins also feels that "a model with only 10 or 20 decision variables can be far more instructive than the large-scale models. . . (p. 477)." McNamara (1971) echoed Hopkins' thoughts by stating "mathematical applications to management should stay clear of large general models and concentrate on specific problems (p. 440)."

The belief that cost simulation techniques can be useful tools for dealing with small, specific educational problems rests largely on theory.

> In light of the prevailing emphasis on systems analysis in education, there is an emerging literature that advocates the use of management science and operations research models as a means to increase the efficiency of educational planning and decision making (Knezedich, 1969). Too often, however, the intent of these articles is to focus on the advantages of applying models rather than to provide empirical research that illustrates the unique contributions of such models in generating solutions for real and immediate educational problems.
>
> (McNamara, 1971, p. 420)

Although empirical evidence is lacking, the theoretical base is both reasonable and impressive. However, the theoretical structure rests upon assumptions which many educators may find less than palatable.

The use of a cost effectiveness technique requires the ability to generate several different methods of achieving the same objectives (Nathanson, 1972). These methods are then analysed to determine which can be implemented at the lowest cost. This method is then considered to be the most cost effective. For example, the goal may be to determine the most cost effective method for teaching a course. Method variables would include class size and instructional variables such as the use of laboratories, videotaped lectures, programmed texts, and computer aided instruction. However, a cost analysis can not be applied to a situation where the objectives can not be stated or when there is a conviction that one and only one

method can be used to achieve the objectives. The use of cost effectiveness analysis, therefore, assumes objectives and several viable means for achieving these objectives.

While many educators may find these assumptions untenable, they are supported by substantial theory and empirical evidence. Both Mager (1962) and Popham (1968) have presented impressive theoretical arguments for the use of objectives. The feasability of using various methods for achieving the same objectives is supported by both theory and empirical evidence. According to Gagne (1970),

> First, no single medium is likely to have properties that make it best for all purposes. When effectiveness of one medium is compared with another for instruction in any given subject, it is rare for significant differences to be found. Lectures have been compared with reading, lectures with motion pictures, pictures with text, and many other kinds of comparisons have been made without revealing clear superiority for any given medium. . . Over a period of years, researchers have learned to be skeptical of single instances of reported statistical superiority of one medium versus another.
>
> Most instructional functions can be performed by most media. The oral presentation of a teacher can be used to gain and control attention, but so also can the use of paragraph headings in a textbook, or an animated sequence in an instructional motion picture. The learner can be informed of the expected outcomes of instruction by a printed text, by an oral communication, or in some instances by a picture or diagram. Recall of prerequisite learned capabilities can be done by oral communication, by means of a sentence or picture in a text, or by a movie or television pictorial sequence. Similar remarks could be made about every one of the functions of instruction described in this chapter. . .the most reasonable generalization is that all media are capable of performing these functions.
>
> In general, media have not been found to be differentially effective for different people. It is an old idea that some people may be "visual-minded" and therefore learn more readily from visual presentation, while others may be "auditory-minded," and therefore learn better from auditory presentations. While a number of studies have been conducted with the aim of matching media to human ability differences, it is difficult to find any investigations from which one can draw unequivocal conclusions (pp. 363-364).

Dubin and Taveggia (1968), after reviewing ninety-one studies,

concluded that no significant differences have been found among a wide range of teaching technologies. This conclusion is supported by Dubin and Hedley's (1969) review of over one hundred studies of the efficacy of instructional television. Reid and McLennan (1967) reached a similar conclusion after reviewing three hundred and fifty studies comparing film and television with other instructional methods. Glaser (1972), while reviewing the results of the aptitude-treatment-interaction studies which attempted to determine whether aptitudes can predict which one of several learning methods might help different individuals attain similar educational outcomes, stated

> few or no aptitude-treatment-interaction effects have been solidly demonstrated; the frequency of studies in which the appropriate interactions have been found is low; and the empirical evidence found in favor of such interactions is often not very convincing (p. 8).

These findings certainly support the assumption that various alternate methods may be used to achieve the same instructional objectives. Therefore, when viewed from a theoretical perspective, cost effectiveness techniques are applicable to instructional situations with clearly specifiable objectives such as most classroom instruction.

When viewed from a practical perspective, on the other hand, the applicability of cost effectiveness techniques is less evident. First and foremost, utilization of the technique must save more than it costs. This means that the technique can be accurately and reliably used to identify the least expensive method of achieving a given set of objectives; that the method identified can and will be implemented; and that the resulting savings will be greater than the cost of utilizing the technique.

Evidence indicating the reliability and accuracy of cost effectiveness

techniques applied to instructional systems simply does not exist. This evidence can only be generated by the successful application of the technique. On the other hand, no unsuccessful attempts have been reported. The accuracy and reliability of the techniques when applied to corporate activity have been well documented (Vance, 1959). But the corporate cost accountant who is well trained in the art of predicting the cost of various alternatives has, as yet, no educational counterpart. Also, the corporate environment is not identical to the educational environment. Therefore, until either success or failure has been documented, the educator who wishes to employ the techniques must proceed with faith in both cost effectiveness and his ability to employ the method.

Even if cost effectiveness analysis is a valid technique which can reliably identify the least expensive alternative, the exercise is not worthwhile unless the alternative can and will be implemented. A sophisticated analysis which produces recommendations which are ignored benefits no one. If this occurs, the resources allocated for the analysis have been wasted and the productivity of the entire system has been lowered. In short, the use of cost effectiveness techniques in a hostile environment may be counter-productive. (See Smith, 1971.)

Since cost effectiveness techniques have not been applied to instructional systems, their ability to generate savings remains to be verified. The criteria, however, are clear. The cost of utilizing the technique plus the cost of implementing the least expensive method must be less than the cost of the currently used method. Or, in the case of new programs, the utilization cost plus the implementation cost must be less than the cost of the method which would have been selected if the

technique had not been employed. It is conceivable that educational decision makers intuitively select the least cost method (Elmore, 1953). If this is true, cost effectiveness techniques may represent only an unnecessary, additional expense.

Is the application of cost effectiveness techniques to small scale instructional systems cost effective? This is an empirical question which can not be answered with existing data. Instead, it must be answered with what must be viewed as subjective and tentative opinions. The feeling that cost effectiveness techniques can be effective in small scale instructional systems may simply be an erroneous conclusion drawn from the juxtaposition of the idea that cost effectiveness is a valuable managerial tool with the opinion that cost effectiveness is inappropriate for large scale instructional systems. On the other hand, a careful examination of the differences between large and small scale systems seems to indicate that the techniques may be more viable in the small system.

The most obvious difference between a cost effectiveness study of an entire college and a study of a single module lies in the mass of data which must be handled. The number of alternate methods for the operation of a college vastly exceeds the number of methods of teaching a single unit. Since a larger number of alternatives requires a larger number of predictions, the probability for error is greatly increased. With a large mass of data and a complex analysis, these errors may become camouflaged and difficult to detect. A smaller system should be easier to monitor and errors should be easier to detect. Inherent in these arguments is the assumption that the economy of scale is not operational and that, in fact, diseconomy of scale will be the rule rather than the exception. This

appears appropriate and is not unprecedented (see Hirsch, 1960). The costs associated with data analysis, for example, would be improportionately larger for the large scale system because of the necessity for designing elaborate computer programs.

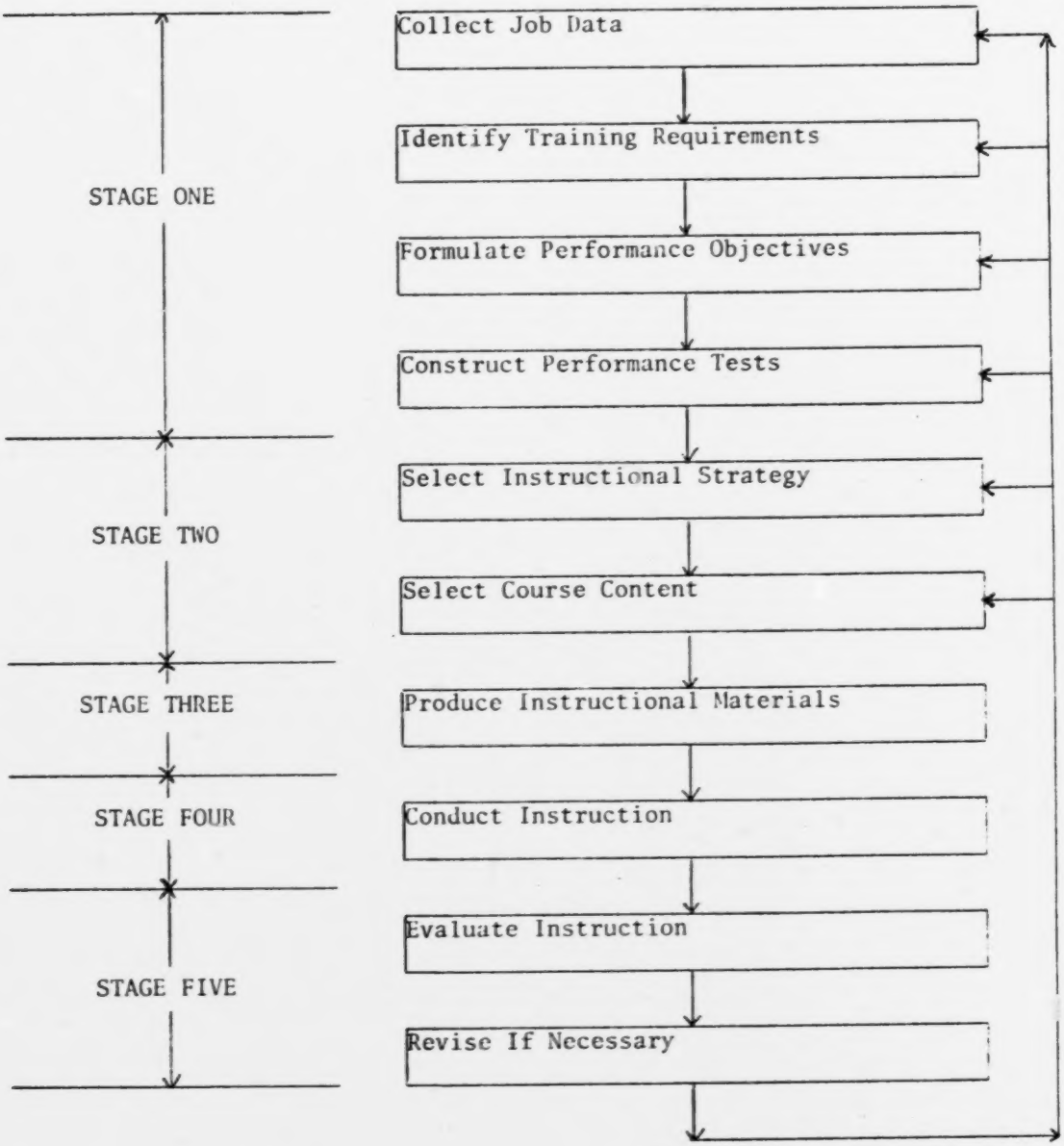
The comparison also reveals the inappropriateness of the application of cost effectiveness to large scale instructional systems. First, few colleges or other large systems have a complete set of clearly specified objectives. Second, since the operation of a large scale instructional system involves the cooperation of many semi-autonomous decision makers, resistance to the changes recommended by the analysis may be quite formidable and difficult to overcome. The difficulty of achieving consensus within a group of semi-autonomous decision makers is probably another good example of the diseconomy of scale. Determination of the cost effective method for a subsystem such as a single module can be much less of a problem, especially if the objectives of the subsystem are clearly specified and the decision makers involved are enthusiastic. The probability of discovering a subsystem with these attributes is far greater than the probability of discovering a large scale system with similar attributes.

The concept of applying cost effectiveness techniques to instructional systems is still in its infancy. It is not amenable to evaluation by philosophical consideration. The technique must be applied before it can be judged. The criteria is quite simple -- either money will be saved or money will be lost. This will be the test of its worth.

III. Description of a Cost Effectiveness Model

Several models for the systematic development of instruction are currently being used in a wide variety of situations. These models range from the very simple to very complex specifications of step-by-step approaches to developing instruction. Since these models do not currently incorporate cost effectiveness analyses, a modified version of the relatively simple Project MINERVA Model developed by Tracey (Tracey, Flynn, and Legere, 1967) will be utilized as the basic design model. This model will be divided into five stages. The necessary cost effectiveness analyses which must be performed at each stage will then be described. Finally, the cost effectiveness procedures will be synthesized with the modified MINERVA model to produce a cost effectiveness model for instructional development.

Modified MINERVA Model



The MINERVA model is not a linear model but has been modified to this form for the purposes of analysis. The actual MINERVA model is presented in Appendix A.

Stages of Instructional Development

The first stage of instructional development consists of those activities which culminate in the specification of performance or behavioral objectives of the type described by Mager (1962), the construction of measuring instruments designed to determine the achievement of the objectives, and the establishment of the criteria required for mastery. The scope of these activities varies. Occasionally, the instructional design process is initiated by an instructor whose students are failing to achieve his well stated objectives. Or, the process may be begun because of the need to teach a new skill or technique which has not yet been defined in terms of objectives. Instructional development nearly always occurs as a response to a need or a problem. The exact nature of this problem will determine the activities which occur prior to the specification of objectives and measuring instruments.

In higher education, the activities in the first stage are generally performed by the instructor or content matter specialist and an instructional designer with expertise in the specification of objectives and the development of measuring instruments. The major cost incurred during this stage is the cost of the time expended by the content matter specialists, the instructional designer and their secretarial support. The costs of supplies consumed during this stage are usually quite minor. The level of productivity at this stage depends upon the interaction of the two individuals. Occasionally, a great deal of time will be spent establishing a personal relationship and/or role expectations. Since these factors are difficult, if not impossible, to predict, no formula or method for determining the least cost method for formulating objectives and constructing measuring instruments will

be considered.

The second stage of instructional development is devoted to the selection of instructional strategy and course content. The selection of instructional strategy consists of deciding to use either an expository or inquiry approach for achieving an objective (Gerlach and Ely, 1971, p. 15). Both approaches may be utilized for different sets of objectives within the same module.

At this stage, the degree to which content is specified varies considerably. In some situations, the content will be delineated only in general terms. The exact content will be determined as part of the process of producing the instructional materials. On the other hand, some instructional designers prefer to specify the exact content during this stage.

The costs associated with the specification of content are primarily the costs of the time used by the members of the instructional design team. The next stage in the development of this module requires the prediction of the costs of presenting the content in various alternate methods. If these predictions are made by different individuals, then each must first make some assumptions concerning the content based upon the objectives. However, if these individuals are asked to make predictions based upon both objectives and content specifications, then duplication of effort will be eliminated, the time required to make the predictions will be diminished, the costs of the predictions will be reduced, and the cost effectiveness analysis will be more cost effective. Knowledge of the exact content may also increase the accuracy of their predictions. For these reasons, the exact content should be determined during the second stage of the instructional development process.

According to the modified MINERVA model, the third stage consists of the production of the instructional materials. However, before the materials can be produced, the method of presenting the materials must be determined. Since the objectives may be achieved through a variety of alternate methods, the costs of producing the materials for each alternative must be analysed prior to the selection of a specific method.

The following is a list of possible alternatives:

1. Film
2. Videotape
3. Programmed text
4. Text material
5. Lecture
6. Slides
7. Filmstrips
8. Audiotape
9. Transparencies
10. Real objects

These alternatives may be used alone or in combination. For example, an instructional module may include a lecture, a slide/tape presentation and a programmed text. While the number of possible alternatives may be large, the number of viable alternatives in a given situation may be much smaller. The use of a programmed text is not a viable alternative if an appropriate text is not commercially available and the talent required to produce a programmed text can not be secured. The choice of a viable alternative is a function of the available resources rather than a function of the objectives. Once viable alternatives have been specified, the cost of

producing each alternative must be predicted. The procedures for making these predictions will be presented in the next chapter.

The fourth stage of the modified MINERVA model consists of conducting instruction. Instead of conducting instruction, the costs associated with using each viable alternative should be predicted. The alternative which can be produced at the lowest cost will not necessarily be the alternative which can be utilized at the lowest cost. The predictions of utilization costs should include consideration of the number of students using or experiencing the module and the length of time the module will be utilized. Consideration of the number of students allows for the prediction of the number of copies or the number of duplications of each alternative. While the cost of producing the first copy is predicted during stage three, the number of copies required and the cost of duplication is predicted in stage four. Consideration of the length of time the module will be used allows the cost of each alternative to be distributed over the life of the module. The procedures for making these predictions will also be presented in the next chapter.

The fifth stage of the modified MINERVA model consists of the evaluation and the revision of instruction. However, during this stage in the cost effectiveness model being developed, alternate methods of administering and scoring the evaluation instruments designed during stage one must be considered, and the costs of each alternative should be predicted. These instruments may be administered by the students, the instructor, a graduate assistant, or a secretary. They may be administered on a group or individual basis. No matter who administers the measuring instruments, these instruments may be scored by the students, the instructor,

a graduate assistant, a machine, or a secretary. One exception to these generalizations warrants mention. When a computer is employed to manage instruction, the evaluation instruments are both administered and scored by the computer. The costs of producing the instruments is included in the cost of administration.

Once the instruments have been administered and scored, the data which has been generated should be analysed and used as a basis for revising both the instruction and the measuring instrument, if necessary, and for providing diagnostic and/or prescriptive information to each student. During this stage, the costs of revising, analysing the data, and providing diagnostic information should also be predicted. The procedures for making these predictions will be presented in the next chapter.

After specifying alternate methods and predicting the costs of producing, utilizing, evaluating, and revising each alternate method, the alternatives can be rank-ordered on the basis of cost. This information allows for the selection of the alternative to be used on the basis of cost. If the least cost method is not selected, the probable additional expense which will be incurred can be determined. The model is not designed to make decisions. The model is designed only to provide cost data which may be used in the decision making processes. After selecting the alternative to be used, stages three, four, and five of the modified MINERVA model may be implemented. The actual costs incurred during the implementation of these stages should be recorded and compared with the predicted costs. Discrepancies may be attributed to either inaccurate predictions, unforeseen modification in design and/or utilization, or unexpected changes in the level of staff productivity. The interpretation and prevention of

discrepancies between actual and predicted costs will be discussed in the final chapter.

Cost Effectiveness Model for Instructional Development

I. Stage One

A. Collect job data

B. Identify training requirements

C. Formulate performance objectives

D. Construct performance test

E. Establish criteria

F. Record costs incurred

II. Stage Two

A. Select instructional strategy

B. Specify course content

C. Record costs incurred

III. Stage Three

A. Specify all viable alternatives

B. Predict cost of producing each alternative

C. Predict cost of using each alternative

D. Predict cost of administering evaluation instruments

E. Predict cost of scoring evaluation instruments

F. Predict cost of analysing test results

G. Predict cost of revising instruction

H. Predict cost of revising measuring instruments

I. Predict cost of providing diagnostic and/or prescriptive information

IV. Stage Four

A. Rank-order viable alternatives on the basis of cost

B. Select alternative to be used

V. Stage Five

A. Produce instructional materials

B. Record costs incurred

C. Compare actual costs with predicted costs

VI. Stage Six

A. Conduct instruction

B. Record costs incurred

C. Compare actual costs with predicted costs

VII. Stage Seven

A. Evaluate instruction

B. Provide students with diagnostics

C. Record costs incurred

D. Compare actual costs with predicted costs

VIII. Stage Eight

A. Revise instruction and/or measuring instruments

B. Record costs incurred

C. Compare actual costs with predicted costs

The above cost effectiveness model represents an expansion of the modified MINERVA model to include procedures for predicting, collecting, and analysing costs.

IV. Procedures for Predicting Costs

COSTS

Implementation of the cost effectiveness model described in the previous chapter requires the prediction of costs. However, this model is not designed to predict all costs associated with providing instruction. This model views costs from the perspective of the department or organization providing the instruction and is designed only to predict the costs which will be actually incurred by the organization. For example, since departments normally do not pay students to attend classes, the cost of students' time is a variable which has been omitted from this model. On the other hand, since departments normally pay for the instructors' time and for the facilities students use, these variables have been included. In order to make this model usable in as many situations as possible, procedures have been included for predicting all costs which a department may incur. However, in specific situations, predictions of some of these costs may be unnecessary. For example, if this model is being used by a department and instructional space is provided by the college or university at no charge, then predictions of the costs of instructional space may be omitted. In general, goods or services which are provided to the department at no charge are omitted from the model.

Utilization of the model rests heavily on the ability to predict the cost of both labor and equipment. The cost per hour of all personnel and equipment must be determined. While many organizations have these

figures readily available, others do not. Therefore, methods for determining these costs are presented in Appendicies B and C.

In this paper, costs will be viewed from the perspective of an organization to be called an instructional product development center. The purposes of the center and the goods and services it provides will now be described.

Purposes

The purpose of the instructional product development center is to provide instructional support to faculty. This instructional support is limited to:

1) Providing assistance to faculty members in the design of instructional materials
2) Producing instructional materials in the following formats:
   a) Transparencies for use with an overhead projector
   b) 35mm slides
   c) Audiotapes (open reel and cassette)
   d) Super 8mm films (silent and sound)
   e) Printed materials
   f) Videotape (1/2" helical scan)
   g) Filmstrips
3) Duplicating previously produced materials
4) Providing faculty with assistance in learning techniques for using instructional materials
5) Producing instruments designed to measure the learning which occurs as a result of the use of instructional materials
6) Providing faculty with assistance in analyzing data obtained through the use of evaluation instruments.
7) Providing assistance to faculty in evaluating, selecting, and purchasing commercially produced instructional materials
8) Providing faculty with the equipment necessary for the use of instructional materials
9) Providing faculty with a small amount of instructional space (classrooms) to use instructional materials

10) Providing personnel to assist faculty in the use of instructional materials and the administration of evaluation instruments.

Job Categories

The purposes of the instructional product development center clearly indicate that the center has been organized to produce materials and provide services for faculty members. In order to facilitate the administration of the center and to determine the cost of the goods and services, they have been placed into categories. These are presented below. Each statement preceded by a two-digit number is a job category. Each statement preceded by a three-digit number is considered to be a specific job within a category. The three-digit number will be referred to as the "job code." The term "project" will be used to refer to the series of jobs required to produce a specific product or service. All jobs except 701, 751, and 801 are performed by the center. For jobs 701, 751, and 801, the center acts as an intermediary between the faculty members and an external agency which performs the job.

10 Instructional Assistance

101 Assist faculty members in specifying objectives

102 Assist faculty members in performing task analyses

103 Assist faculty members in sequencing instruction

104 Assist faculty members in preparing verbal materials (including assistance in script writing)

15 Library Assistance

151 Assist faculty members in locating commercially produced instructional materials

152 Assist faculty members in ordering commercially produced instructional materials

20 Evaluation

201 Assist faculty members in writing test items

202 Assist faculty members in interpreting test scores

203 Assist faculty members in evaluating commercially produced materials

204 Assist faculty members in administering evaluation instruments

30 Art Work

301 Producing charts, maps, signs, and billboards

302 Producing drawings

303 Producing art work to be used as originals or masters for transparencies for an overhead projector

304 Producing art work for 35mm slides

305 Producing, from originals or art work, transparencies for the overhead projector using the diazo or thermo-fax process (including mounting)

306 Copying transparencies using the diazo process

40 Photography

401 Photographing art work, originals, or materials in a book to produce transparencies for the overhead projector

402 Producing 35mm slides from art work, originals, or materials in a book

403 Developing film

404 Producing black and white prints

405 Photographing (35mm) real objects in center

406 Photographing (35mm) on location

407 Filming (Super 8mm) in studio

408 Filming (Super 8mm) on location

409 Producing 35mm slides from filmstrips or 16mm film

410 Editing Super 8mm film

411 Sequencing slides

412 Copying slides

413 Copying transparencies for the overhead projector

45 Audio

451 Recording one source in a studio

452 Mixing and recording more than one source in the studio

453 Recording one source on location

454 Mixing and recording more than one source on location

455 Synchronizing slides with an audiotape

456 Recording a soundtrack on magnetic stripe film

457 Dubbing sound on videotape

458 Duplicating audiotapes or copying records on audiotape

50 Videotape

511 Videotaping on location

512 Videotaping in the studio

513 Editing videotape

514 Technical consulting with faculty wishing to do their own videotaping

55 Duplication

551 Preparing original

552 Preparing stencil or master

553 Producing copies from stencil or master

554 Collating

555 Photocopying

60 Facilities for Faculty Use

601 Providing Classroom A

602 Providing Classroom B

65 Equipment for Faculty Use

651 Providing equipment for faculty use (pick-up, delivery, operating equipment)

70 Production of Filmstrips

701 Producing filmstrips

75 Production of Print Materials in Quantity

751 Producing print materials in quantity

80 Data Processing

801 Processing evaluation data

Although the system used to determine the cost of providing these goods and services will not be described in detail within this paper, some general procedures will be outlined. Whenever a specific job is performed, a work order is filled out. This work order serves as a record of the materials and the amount of labor utilized. This information is transferred to IBM cards for computer processing. In general, the cost of the job consists of the sum of the cost of materials plus a standard charge for each hour of labor. This standard charge includes all indirect expenses such as space, equipment, maintenance, and administrative support. All information pertaining to the cost of a job is stored on magnetic tape. This information may be retrieved in a variety of formats designed to facilitate the prediction of future costs.

Assume that the first two stages of the instructional design model have been completed and the problem is to predict the costs of producing, using, and evaluating various instructional alternatives. Before the costs of producing and using various alternatives can be predicted and analyzed, the viable alternatives must be delineated. Seven basic methods for presenting instruction are listed below:

1. Audiotape
2. Film
3. Lecture
4. Printed materials
5. Slides (35mm)
6. Transparencies for an overhead projector
7. Videotape

These methods may be utilized individually or in any combination to generate a single alternative.

The use of a table is a convenient way to facilitate the specification of alternatives. All the viable methods are listed in the left hand column. A column is provided to the right for each alternative to be considered. Each objective is numbered, examined, and assigned to various methods in various alternatives. The resulting matrix will be similar to the one presented below.

Alternative Method Matrix

Viable Methods	Alternatives		
	Number One	Number Two	Number Three
	Objective Number	Objective Number	Objective Number
1. Lecture and Transparencies	1, 7, 13, 14	6, 8, 12, 19	1, 7, 15, 16
2. Videotape	2, 4, 8, 11	7, 8, 9, 11	
3. Slide/ Audiotape	3, 18, 19, 20	1, 2, 3, 4, 18, 20	13, 14, 17, 18, 19, 20
4. Film	5, 10, 15, 16		2, 3, 4, 5, 6, 8, 9, 10, 11, 12
5. Printed Material	6, 9, 12, 17	5, 7, 10, 13, 14, 15, 16, 17	

This five method, three alternative matrix for a set of twenty objectives is presented only as an example. In practice, the matrix could be enlarged or reduced by adding or subtracting methods or alternatives.

The assignment of a specific objective to a particular method within an alternative is done solely on the basis of the subjective judgment of the instructional designer and the content matter specialist. If there is a basis for believing that learning will be facilitated by achieving the objectives in a specific sequence, the objectives may be sequenced and

assigned to alternatives and methods in blocks.

Once the objectives have been categorized, the viable methods must be analyzed to determine which jobs must be performed to produce the necessary instructional materials. At the same time, the number of units to be produced must also be estimated. The first step in this process is to write a general description of the type and amount of materials required. Since the objectives and the content have already been determined, this is not a particularly difficult task.

The general description of the materials to be produced for alternative three in the table presented above is as follows:

A. Set of 30 transparencies for the overhead projector
    1. 20 produced from original art work by the Center's artists
    2. 10 produced photographically
B. Slide/Tape presentation
    1. Set of 90 slides
        a. 40 produced from art work by the Center's artists
        b. 15 photographed from materials in books
        c. 15 photographed from real objects in the Center
        d. 20 photographed on location
    2. Twenty minutes of audio
        a. mixed and recorded entirely in the studio
        b. tape synchronized with slides
C. Super 8mm film
    1. Approximately 30 minutes long
    2. Filmed on location
    3. Sound mixed and recorded on location

Once the materials have been described, the information is transferred to a table which lists the jobs and the number of units to be delivered. A sample of the table for alternative three is presented on the following page.

At the bottom of the table, the user indicates the information which is desired. Two types of reports are available. These will be briefly described.

Project Number: ____

Alternative Number Three (Predicted Costs)

Jobs	Units Required	Average Unit Cost	Cost of Required Units
303	20		
304	40		
305	20		
401	10		
402	45		
403	10		
405	15		
406	20		
407	15		
408	30		
410	30		
411	90		
452	20		
454	30		
455	90		
456	30		
		TOTAL COST	

___ Request For Data

___ High, Low, and Averate Unit Costs

___ Detailed Job Cost Report

High, Low, and Average Unit Cost Report

All job costs for each category listed are analyzed.

The highest unit cost incurred to date is reported for each category.

The lowest unit cost incurred to date in each category is reported.

The total cost of all jobs, divided by the number of units produced, is reported for each category.

Each of the three costs are multiplied by the number of units required. These costs are then totalled to indicate the cost of the project if the highest, lowest, or average unit costs are incurred. A sample of this report is presented in Appendix E.

Detailed Job Cost Report

All jobs performed to date are individually listed by category. The cost of each job, the average job cost, the average unit cost, the variance in unit costs, the standard deviation of the unit cost, and the percentage of jobs in which the reported unit cost was between plus and minus one standard deviation of the average unit cost is reported for each category.

A sample of a Detailed Job Cost Report is presented in Appendix F.

The information in these reports may be used to predict the costs which will be incurred if alternative three is implemented. Normally, the prediction will be based on the average unit cost. However, if a specific job appears

particularly easy or difficult, a higher or lower than average unit cost may be used. Once predicted, the unit costs are entered in the table and the costs of the required units are computed and recorded. The unit costs are totalled to determine the total cost of producing one unrevised copy of the materials.

The cost system employed by the Center allows for the determination of a unit cost which is relatively insensitive to volume. The cost of each unit produced during a specific period does not depend upon the number of units produced during that period. Therefore, only a very small percentage of the variance in unit costs may be attributed to variance in volume. The cost system has been designed to yield unit costs which are relatively stable. Variance in unit costs can be attributed to the use of different types of materials or differences in productivity. When the same materials are used, any variance in unit costs is clearly attributable to productivity.

The next step in the analysis requires the prediction of the cost of using the instructional materials. Since the transparencies will be used as a part of the materials presented by the instructor, the predicted cost is:

	Estimated Cost
One hour of instructor's time.	$_____
One hour of classroom space.	$_____
Use of overhead projector.	$_____
TOTAL	$_____

The slide/tape and film may be presented to either the entire group or may be made available for individual viewing. If the materials are viewed by the group, the cost will be:

	Estimated Cost
One hour of instructor's time	$_____
One hour of classroom space	$_____
Use of taperecorder, slide projector, and movie projector . .	$_____
TOTAL	$_____

If the materials are viewed individually, the cost will be:

(Number of students) x (1 hour) = Cost of carrel = $_____

This assumes that the students will each spend one hour viewing the material and will use carrels equipped with the relevant equipment. (In the cost system developed by the author, the charge for using one carrel for one hour includes the cost of space, equipment, maintenance, administrative expense, etc.)

The method which has been described for computing the cost of using the material has been based on the assumption that the material will be used with one group. The size of the group will be reflected in the cost of classroom space or in the number of carrels required. This comparison may not be necessary if the materials are designed to be used in one specific manner. For example, slides designed for individualized instruction may contain a great deal of written material which would be illegible if shown to a large group.

The cost of evaluating the material may be computed. Since the purpose of the analysis is to compare three viable alternatives, and, since each alternative will be evaluated with the same instruments under the same or highly similar conditions, the cost of evaluation will be the same for each alternative and is, therefore, not required for the purpose of comparing instructional alternatives. As pointed out in Section III, several

viable methods of evaluation are usually available. A cost effectiveness analysis of these alternatives may be performed using the procedures which have been described. For example, a "High, Low, and Average Unit Cost Report" for job category 201 will provide unit cost information on test items prepared by the Center. The process of evaluation is considered to consist of a series of jobs. The costs incurred in performing these jobs may be estimated using the same procedures which were employed to estimate the cost of producing an instructional alternative.

Since the first set of instructional materials will seldom achieve the desired degree of effectiveness, it is quite reasonable to anticipate the necessity of altering the materials to correct specific defects and to include predicted revision costs within the analysis. Since a variety of techniques may be used to increase the effectiveness of instructional materials, revision will not be assumed to be limited to only the alteration of the original product. Nevertheless, revision costs may be expressed as a percentage of the original production costs. Historical costs, or the revision costs previously incurred, may be used to estimate this percentage. When job costs are initially recorded, they may be coded to indicate whether the job is being performed to produce new materials or to revise previously produced materials. This allows the cost data on file to be analyzed in order to determine revision costs of projects. The user simply requests a "Report of Revision Costs." This report lists all projects completed to date, initial production costs, revision costs, revision costs expressed as a percentage of initial costs, total of initial costs, total of revision costs, and total revision costs expressed as a percentage of total initial production costs. This information may be used as the basis for estimating revision costs.

Finally, the cost of producing any necessary copies of the revised materials must be estimated. A specific job code has been assigned to each type of copying operation. A "High, Low, and Average Unit Cost Report" for copying jobs will provide the necessary information. Normally, this information will be requested at the same time as the unit production costs. The report allows the estimation of the cost of making one copy of one unit. The user must compute the cost of making the required number of copies of the predicted number of units. The duplication information may be summarized in a table like the one below.

Type of Material	Number of Units (U)	Number of Copies (N)	N x U	Cost of Copying One Unit (C)	Estimated Duplication Cost N x U x C
A. Slides	90	5	450	$_____	$_____
B. Audiotape	20	5	100	$_____	$_____
C. Super 8mm	30	5	150	$_____	$_____
				TOTAL	$_____

When all the costs have been estimated for each viable alternative, the information should be summarized in a table to facilitate comparisons.

Estimated Costs	Alternatives One	Two	Three
1. Production	$_____	$_____	$_____
2. Utilization	_____	_____	_____
3. Revision	_____	_____	_____
4. Duplication	_____	_____	_____
5. Total	$_____	$_____	$_____

The information in a table such as the one above should be considered to be only one factor in selecting the alternative to be implemented. The importance of this factor shall be left to the discretion of the individual charged with the responsibility of selecting the alternative to be implemented.

V. Procedures for Improving the Accuracy of Estimated Costs

The cost effectiveness model which has been described depends heavily upon the ability to accurately and reliably predict costs. These predictions are based on historical costs. In the absence of any other information, the mean is the best estimate. However, cost estimates are seldom made in the absence of any other information. The problem is to determine which information is relevant and which is not important.

The cost system designed by the author allows predicted costs to be recorded and stored for subsequent comparison with the costs which were actually incurred. The predictor may request a report which is, in essence, a list of every job predicted, the predicted cost, the acutal cost, the difference between actual and predicted costs, and the ratio of the difference between the predicted and the actual costs expressed as a percentage. An analysis of this report allows the predictor to identify those job costs which are most accurately and least accurately estimated.

The sources of serious errors may be at least partially identified by thoroughly analyzing the job. Certain factors, such as equipment malfunctions, film lost in the mail, and inclement weather, cannot be anticipated and allowed for in the initial estimates. Other factors, such as the need for special materials or the necessity of filming or taping in adverse environments, can be anticipated. Analyzing jobs which were incorrectly estimated allows the predictor to determine which of the factors contributing to the error should have been anticipated. Hopefully, this knowledge will prevent these factors

from being overlooked in the future.

VI. Comments and Suggestions

This paper has two obvious, and perhaps somewhat irritating, shortcomings. First, no cost information has been provided. Second, the costing system referred to in the paper has not been described. Although this information is available and could have been included, it has been omitted for several important reasons.

This paper has been prepared for general distribution. The author's experience has led him to believe that few readers without an accounting background are able to interpret reported costs. Any figure reported as the cost of providing goods and/or services must be interpreted as a cost which has been derived by analyzing a specific environment with a specific accounting system or procedure. If the environment or the accounting procedure changes, the cost will change. This means that the reported costs are meaningful only to those who have an understanding of both the accounting system and the environment in which the system was used. Since few individuals outside any organization possess this information, publicly reported costs will be, at best, ignored by the sophisticated reader and, at worst, seriously misinterpreted by the unsophisticated.

The Internal Revenue Service requires commercial organizations to follow generally accepted accounting procedures. Since a wide variety of procedures are acceptable, the same ones must be followed consistently. To insure that these procedures have been followed, the organization must be audited and certified by an independent entity such as a public accounting

firm. The cost information usually reported in the educational literature is seldom certified by an independent auditor. Therefore, any credibility given to the accuracy of these figures must be based on the belief that standard accounting procedures have been consistently and accurately employed. Costs which are reported as evidence to support the cost effectiveness of specific instructional strategy or instructional technology should be particularly suspect. All too often the non-accountant will employ procedures for analyzing cost information which ignore or overlook certain costs and thereby produce cost figures which are artificially low. These errors are not a great deal unlike those made by educational researchers with a very strong desire to produce results which are statistically significant.

This paper has focused upon methods for analyzing cost data which has been recorded and pays only cursory attention to the system used to record and process cost data. To some, this may appear analogous to putting the cart before the horse. This is, however, not true. The author is aware of several institutions in various stages of developing costing systems. The development of these systems is seldom hampered by a lack of understanding of the mechanics of accounting. This expertise is readily available to most institutions. The problems which arise are frequently due to a lack of understanding of the manner in which the information will be used. For example, the system developed by this author is useful for predicting future unit costs. For this reason, procedures for allocating indirect costs have been used which greatly reduce the influence that the number of units produced exerts on unit costs. The system is also designed to store, process, and retrieve unit costs in a variety of formats. Even worker productivity is analyzed in terms of the variance in the unit costs of his products. However, individuals or organizations with different costing problems may find little value in

this system.

The initial stages of the design of any costing system must focus on the objectives to be achieved by that particular system in a specific environment. In a sense, this paper may be conceived of as a description of a set of objectives which are achieved by one system. These objectives are offered to the reader for consideration. Once the objectives have been accepted, the author will be happy to discuss in detail the type of system required to achieve them.

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APPENDICIES

Appendix A -- Minerva Model

Appendix B -- Cost of Equipment

Appendix C -- Cost of Personnel

Appendix D -- Individuals Developing Costing Systems

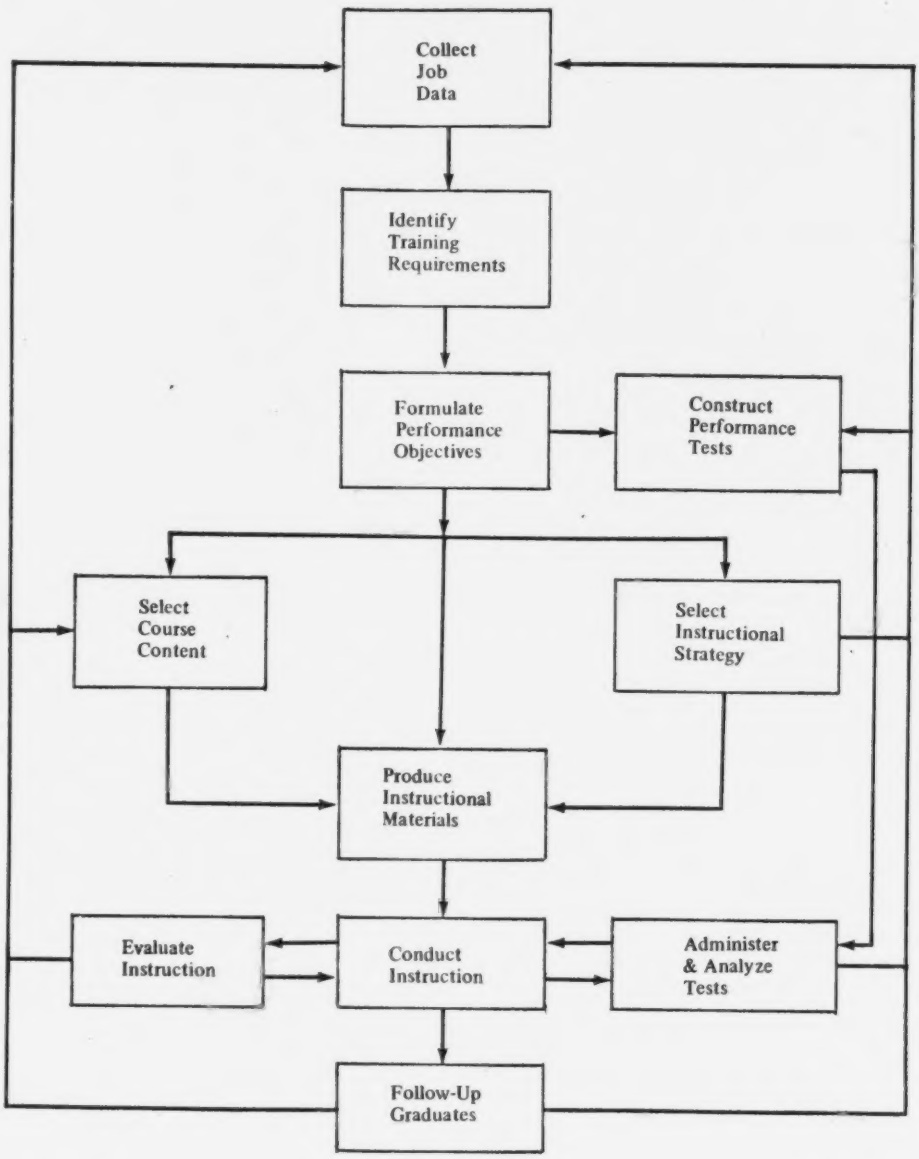
Appendix E -- High, Low, and Average Unit Cost Report

Appendix F -- Detailed Job Cost Report

APPENDIX A

Minerva Model

A FLOW DIAGRAM OF THE PROJECT MINERVA MODEL.



APPENDIX B

Cost of Equipment

The Instructional Product Development Center has budgeted $8,278 for equipment. These funds are used to replace equipment which has worn out with similar equipment or with new types of equipment designed to increase productivity. The amount budgeted per year is determined by the formula:

$$\frac{\text{(Initial cost) - (Value at end of usable life)}}{\text{(Usable life expressed in years)}}$$

The usable life and the value at the end of the usable life must be estimated for each piece of equipment. The Internal Revenue Service (IRS) provides guidelines for commercial organizations which may be consulted as an aid in estimating usable life. However, the IRS guidelines have some serious limitations and must be used with caution. These guidelines have <u>not</u> been established to facilitate the prediction of the usable life of a piece of equipment. They have been established to restrict the rate at which a business may depreciate the value of its assets. At this time, the IRS does not provide guidelines for equipment such as cassette recorders, overhead projectors, and small format videotape equipment. These guidelines are expected to be published in July, 1973. Until that time, the IRS will accept any estimate which appears reasonable. Although the educational decision-maker is not faced with the problems associated with the regulations imposed by IRS, their suggestion of using reasonable estimates is quite appropriate. A reasonable estimate of an item's usable life will require an analysis of the environment in which the equipment is used, the competency of the personnel using the equipment, the frequency of use, and the availability and quality of preventive maintenance.

The equipment and furniture used by the Center is listed below. The usable life should be interpreted as reasonable for this specific center.

The scrap value has been estimated at approximately ten percent of the initial cost.

Location	Item	Initial Cost	Scrap Value	Usable Life	Annual Costs	
Director's Office	Desk	$ 176	$ 18	12	$ 13	
	File Cabinets	120	12	10	11	
	Chairs	220	22	8	25	
	Dictaphone	90	9	5	16	
	Bookcase	60	6	12	4	
					$ 69	$ 69
Asst. Director's Office	Desk	$ 176	$ 18	12	$ 13	
	File Cabinets	120	12	10	11	
	Chairs	128	13	8	14	
	Dictaphone	90	9	5	16	
	Bookcase	60	6	12	4	
					$ 58	58
Evaluation Specialist's Office	Desk	$ 176	$ 18	12	$ 13	
	File Cabinets	180	18	10	16	
	Chairs	128	13	8	14	
	Dictaphone	90	9	5	16	
	Bookcase	60	6	12	4	
	Calculator	200	20	8	23	
					$ 86	86
Reproduction Area	Mimeo	$ 450	$ 45	8	$ 51	
	Ditto	400	40	8	45	
	Gestetner	1,000	100	8	113	
	Collator	150	15	8	17	
					$226	226
Secretarial Area	Desks	$ 700	$ 70	12	$ 53	
	File Cabinets	600	60	10	54	
	Chairs	230	23	8	26	
	Dictaphones	300	30	5	54	
	Bookcase	120	12	12	9	
	Calculator	200	20	8	23	
	Typewriters	1,800	180	7	231	
	Copier	1,500	150	8	169	
					$619	619
Equipment Storage and Maintenance Area	Desk	$ 146	$ 15	12	$ 11	
	File Cabinet	60	6	10	5	
	Chair	58	6	8	7	
	Typewriter	200	20	7	26	
	Work Bench	87	9	10	8	
	Shelves	300	30	10	27	
	Tools	150	15	10	14	
					$ 98	98

Location	Item	Initial Cost	Scrap Value	Usable Life	Annual Costs	
Librarian's Area	Desk	$ 146	$ 15	12	$ 11	
	File Cabinets	120	12	10	11	
	Chairs	58	6	8	7	
	Bookcases	240	24	12	18	
	Typewriter	200	20	7	26	
					$ 53	$ 53
Equipment for Faculty Use	16mm Projector	$6,000	$600	7	$ 771	
	Super 8mm Projector	1,000	100	7	129	
	Videotape Recorders	7,000	700	6	1,050	
	Video Cameras	3,500	350	6	525	
	Monitors	2,500	250	6	375	
	Filmstrip Projectors	800	80	7	103	
	Slide Projectors	1,600	160	7	206	
	Overhead Projectors	1,900	190	8	214	
	Cassette Recorders	3,600	360	8	405	
	Tape Recorders	1,900	190	8	214	
	Record Players	500	50	6	75	
	Screens	600	60	5	108	
					$4,175	4,175
Television Area	Desk	$ 450	$ 45	12	$ 34	
	Chairs	240	24	8	27	
	VTR	2,000	200	8	225	
	Cameras	1,000	100	8	113	
	Switcher	800	80	8	90	
	Effects Generator	800	80	8	90	
	Microphones	150	15	6	23	
	Mixer	80	8	6	12	
	Tape Recorder	300	30	6	45	
	Record Player	150	15	6	23	
	Lights	800	80	8	90	
	Film Chain	1,500	150	10	135	
	Dollies	160	16	10	14	
	Light Meter	80	8	4	18	
					$ 939	939

Location	Item	Initial Cost	Scrap Value	Usable Life	Annual Costs	
Sound Recording Area	Desk	$ 176	$ 18	12	$ 13	
	Chairs	54	5	8	6	
	Tape Recorders	600	60	6	90	
	Cassette Recorders	250	25	6	38	
	Turn Tables	250	25	6	38	
	Mixer	80	8	6	12	
	Microphones	100	10	4	23	
	Amplifiers	200	20	6	30	
					$ 250	$ 250
Film Preview Area	Chairs	$ 320	$ 32	8	$ 36	
	Projector	600	60	7	77	
	Projection Stand	65	7	7	8	
	Screen	30	3	8	3	
					$ 124	124
Graphic Production Area	Desk	$ 176	$ 18	12	$ 13	
	Chairs	300	30	8	34	
	Tables	600	60	10	54	
	Copier	300	30	8	34	
	Diazo	300	30	5	54	
	Sign Equipment	350	35	5	63	
	Press	430	43	10	39	
	Tacking Irons	20	2	3	6	
	Paper Cutter	75	8	5	13	
					$ 310	310
Supply/Storage	Cabinets	$ 500	$ 50	15	$ 30	
	Shelves	300	30	10	27	
					$ 57	57
Classroom A	Carrels	$5,000	$500	10	$ 450	
	Chairs	800	80	8	90	
					$ 540	540
Classroom B	Desk	$ 180	$ 18	12	$ 14	
	Chairs	585	59	8	66	
	Screen	70	7	10	6	
	Chalkboard	60	6	10	5	
					$ 91	91

Location	Item	Initial Cost	Scrap Value	Usable Life	Annual Costs	
Photographic Production Area	Desk	$ 180	$ 18	12	$ 14	
	Chairs	60	6	8	7	
	Enlarger	300	30	8	34	
	Print Dryer	150	15	8	17	
	Film Dryer	90	9	10	8	
	Copy Stand	150	15	10	14	
	Light Table	50	5	8	6	
	Timer	50	5	5	9	
	Lights	300	30	8	34	
	Slide Copier	500	50	8	56	
	Sheet Camera	350	35	8	39	
	35mm Camera	1,200	120	8	135	
	Super 8mm Camera	300	30	8	34	
	Super 8mm Projector	200	20	7	26	
	Editor	90	9	5	16	
	Paper Cutter	50	5	5	9	
	Flash	180	18	5	32	
	Darkroom Equipment	150	15	6	23	
	Animation Equipment	700	70	9	70	
					$ 583	$ 583
TOTAL						$8,278

APPENDIX C

Cost of Personnel

The method for determining the total adjusted salary of most personnel is relatively simple. The formula below may be used.

Gross salary (amount paid to individual before taxes and deductions)
+ Employer's contribution to Social Security
+ Employer's contribution to fringe benefits (retirement, insurance, etc.)
Total Adjusted Salary

If an individual is paid on an hourly basis, the number of hours to be worked during the year must be estimated. Employer's contributions to fringe benefits may usually be expressed as a percentage of the individual's gross salary. However, since all employees typically do not receive identical fringe benefits, this percentage will vary considerably.

Three of the individuals employed by the Center, the Director, Assistant Director, and the Evaluation Specialist, also teach courses. The compensation which these individuals receive for teaching does not come from funds administered by the Center and is not reflected in the Center's budget.

The Director's gross salary is $24,200 per calendar year. The Director is expected to spend 1,404 hours per year, or 90% of his time, on activities related to the Center. Therefore, the Center pays ninety percent of his gross salary, or $21,780.

The Assistant Director receives a gross salary of $18,500 per calendar year. Approximately 916 hours, or 66% of his time, is spent on Center business. Therefore, the Center pays 66% of his salary, or $12,210.

The Evaluation Specialist receives a gross salary of $17,800 per calendar year. Approximately 916 hours, or 66% of his time, is spent on Center business. Therefore, the Center pays 66% of his salary, or $11,748.

APPENDIX D

Individuals Developing Costing Systems

Individuals Developing Costing Systems

Jack Everly, Director
Instructional Materials Division
University of Illinois
Urbana, Illinois 61801

Currently using a costing system developed by Dan Isaacs and Paul Rao. This system may be the only one which is currently operational.

Dan Isaacs, Director
Media Center
Florida State University
Seminole Dining Hall
Tallahassee, Florida 32304

He developed the system in use at Illinois. At this time, no descriptive information on the system has been published. A paper describing the system is being considered for presentation at the annual meeting of the Association for Educational Communications and Technology to be held in Las Vegas in April, 1973.

Paul Rao
Library
Eastern Illinois University
Charleston, Illinois 61920

Primarily responsible for the computer program used to process the cost data collected at the University of Illinois. Because this program will be part of a doctoral dissertation and because of copyright laws, information on the program has been somewhat restricted.

Don Rogers
Media Education Center
University of Texas
604 W. 24th Street
Austin, Texas 78705

Currently developing a generalized costing system designed for application with only minor modification in a variety of environments. This work is part of a doctoral dissertation which should be available by May 1, 1973.

APPENDIX E

High, Low, and Average Unit Cost Report

Report of High, Low, and Average Unit Costs

User requested highest, lowest, and average unit costs of jobs performed to date in the following categories: 303, 304, 305, 401, 402, 403.

A	B	C	D	E	F	G	H
Job Code	Units Required	Lowest Cost	Average Cost	Highest Cost	B x C	B x D	B x E
303	20	$_____	$_____	$_____	$_____	$_____	$_____
304	40	_____	_____	_____	_____	_____	_____
305	20	_____	_____	_____	_____	_____	_____
401	10	_____	_____	_____	_____	_____	_____
402	45	_____	_____	_____	_____	_____	_____
403	10	_____	_____	_____	_____	_____	_____
			TOTALS		$_____	$_____	$_____

APPENDIX F

Detailed Job Cost Report

Detailed Job Cost Report

User requested cost of all jobs numbered 3 0 1. This information is presented below:

	Job Code	Project Code	Job Cost	Number of Units Delivered	Unit Cost
A.	301	010	$_____	___	$_____
B.	301	011	_____	___	_____
C.	301	012	_____	___	_____
D.	301	038	_____	___	_____
E.	301	045	_____	___	_____
		TOTAL COST	$_____		

Number of jobs = 5

Cost of jobs = $_____

Number of units delivered = ___

Average cost = Cost of jobs/Number of jobs = $_____

Average unit cost = Cost of job/Number of units delivered = $_____

Variance in unit costs = $_____

Standard Deviation of unit costs = $_____

Average unit cost + Standard Deviation = $_____

Average unit cost - Standard Deviation = $_____

Number of jobs in which reported unit cost was greater than $ (average-standard deviation) but less than $ (average + standard deviation) = _____

These _____ jobs represent _____% of the jobs reported.